# IRON ORE COMPANY OF CANADA

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## STUDY TO SELECT AND OPTIMIZE SUBSTITUTES FOR BENTONITE AS A PELLETIZING BINDER WITH CAROL LAKE CONCENTRATE

## PART 2

FINAL REPORT

BY

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On behalf of the Iron Ore Company of Canada and myself, I would like to take this opportunity to express our sincere appreciation and thanks to the Department of Supply and Services Canada and Canmet, especially their designated scientific authority J.M.D. Wilson for the excellent assistance and contribution to our bentonite substitution program.

Tom I. Martinovic

## EXECUTIVE SUMMARY

During the period of March 1988 to October 1988, the Iron Ore Company of Canada conducted the second phase of a major program on the development of an acceptable substitute - organic binder in place of bentonite for the pelletizing of Carol concentrate.

This phase of the program (as was the initial phase) was cosponsored by the Department of Supply and Services Canada and the Iron Ore Company of Canada.

The program covered an evaluation of various binders in the Laboratory tire balling in order to identify the most promising potential organic binders.

The potential binders were supplied by various suppliers. The following binders were tested on tire balling: Peridur C-10 and XC-10, Tacbind, Carbobind 135, Alchem 8C26 and peat moss.

Based on the green ball quality obtained on the tire balling, Peridur C-10, Alchem 8C26 and peat moss were selected for full scale pot-grate testwork. These three potential binders were tested with various pelletizing mixes (acid, dolomite, limestone and fully fluxed).

The pot-grate test results with organic binders were compared with bentonite based pellets. These results showed that an acceptable pellet quality can be produced with the use of Peridur. However, it appears

that for acid pellet production, some flux addition (dolomite or limestone) may be necessary in order to meet all of the physical and metallurgical properties of fired pellets.

Further pot-grate testwork is required to optimize organic binder addition rate, dolomite and limestone addition rates, as well as establishing firing cycles for various pelletizing mixes.

This recommended testwork will conclude the Laboratory phase of the bentonite substitution program and will provide the necessary technical parameters for a potential commercial trial.

Following the completion of the recommended pot-grate testwork a detailed economic assessment will be required in order to evaluate the overall viability of Peridur as a potential binder.

## SOMMAIRE - DIRECTION

Entre Mars et Octobre 1988, la Compagnie minière IOC a entrepris la deuxième phase d'un projet majeur sur le développement de substituts acceptables - agglomérant organique, pouvant remplacer la bentonite utilisée pour le bouletage du concentré de Carol.

Tout comme la première phase, cette deuxième étape du programme fut commanditée par le Ministère de l'approvisionnement du Canda et la Compagnie minière IOC.

Le programme couvre une évaluation de divers essais de mise en boulettes en laboratoire à l'aide d'un pneu, dans le but d'identifier les meilleurs agglomérants organiques.

Les produits d'essais furent fournis par plusieurs fournisseurs et les agglomérants utilisés en laboratoire sont: Péridur C-10 et XC-10, Tacbind, Carbobind 135, Alchem 8C26 et de la tourbe.

Les résultats d'essais par pneu en laboratoire ont démontré que les agents Péridur C-10, Alchem BC26 et la tourbe produisent une boulette verte de qualité supérieure. Ces derniers furent donc choisis pour les essais de cuisson. De plus, ces trois agglomérants potentiels ont été utilisés avec plusieurs mélanges de bouletage tels acide, dolomite, pierre à chaux et boulettes entièrement fondantes.

Les résultats de cuisson avec agglomérant organique ont été comparés avec des boulettes à base de bentonite et ont démontré que l'ont peut produire une boulette de qualité acceptable avec l'utilisation de Péridur. Toutefois, il semblerait que pour produire une boulette acide sur une base de production, it faudrait ajouter une certaine quantité de fondants (dolomite ou pierre à chaux) pour atteindre les exigences physiques et métallurgiques d'une boulette cuite de qualité.

De plus amples essais de cuisson seront nécessaires afin de déterminer avec précision les quantités d'agglomérants organiques requises ainsi que les quantités de dolomite et pierre à chaux. Il nous faudra aussi déterminer les cycles de cuisson pour ces différents mélanges.

Ces derniers essais complètent la phase laboratoire de programme de substitution de bentonite et les résultats obtenus serviront à établir les paramètres techniques pour les essais commerciaux potentiels sur une ligne de production de l'usine de bouletage à Carol.

Après que les essais de cuisson recommandés auront été complétés, une évaluation économique détaillée sera requise afin d'évaluer la viabilité générale du Péridur comme agent liant potentiel.

## INTRODUCTION AND OBJECTIVES

Although acceptable pellet quality can be produced by using bentonite as a binder, its quality, availability and in particular, its rising cost have become important considerations at the Carol Pellet Plant of the Iron Ore Company of Canada. Due to the lack of suitable quality bentonite deposits in Canada, the material has to be imported from the United States and overseas. As a result, transportation costs represent about 70% of the total cost of bentonite.

Even more importantly, an adverse aspect of bentonite addition to the pelletizing mix is increased impurities in the pellets (product) due to bentonite's chemical composition. It increases gangue content in the pellets (adds about 0.5% $SiO_2$) resulting in loss of iron units. This iron unit loss must be compensated by increasing the concentrate grade which decreases the overall iron recovery, which consequently raises the production costs. Also, because more stringent pellet quality demands lower silica, bentonite is becoming a far less desirable binder.

Since this is a continuation of the Bentonite Substitution Program, a reference should be made to the first phase of the program. This phase of the program (as was the initial phase) was cosponsored by the Department of Supply and Services Canada and the Iron Ore Company of Canada.

The second phase of a major program on the development of an acceptable substitute - organic binder as a substitute for bentonite for the pelletizing of Carol concentrate was carried out in two parts (phases).

The first part covered an evaluation of various binders in the Laboratory tire balling in order to identify the most promising potential organic binders.

The potential binders were supplied by various suppliers. The following binders were tested on tire balling: Peridur C-10 and XC-10, Tacbind, Carbobind 135, Alchem 8C26 and peat moss. Based on the green ball quality obtained on the tire balling, Peridur C-10, Alchem 8C26 and peat moss were selected for full scale pot-grate testwork, i.e. part two of this phase.

These three potential binders were tested with various pelletizing mixes (acid, dolomite, limestone and fully fluxed). The pot-grate test results were compared with bentonite based pellets.

The complete testwork, i.e. the Laboratory and pot-grate testwork was carried out at Centre de Recherches Minerales, Quebec City. Therefore, all of the details on the testwork program findings can be obtained from CRM's report. The work on this project was conducted under the auspices of the Canada Center for Mineral and Energy Technology,

Energy, Mines and Resources, Canada. The designated Canmet scientific authority was J.M.D. Wilson, who continuously monitored the progress of the program and closely worked with the Iron Ore Company of Canada's designated Chief Process Engineer, Tom I. Martinovic.

## CONCLUSIONS AND RECOMMENDATIONS

An overall assessment of a major program on the development of an acceptable substitute - organic binder for bentonite for the pelletizing of Carol concentrate concluded the following:

1. Laboratory tire balling tests were carried out using several potential binders: Pendur C-10, XC-10, Tacbind, Carbobind 135, Alchem 8C26, and peat moss. Based on the green ball quality obtained on the tire balling, Peridur C-10, Alchem 8C26 and peat moss were selected for full scale pot-grate testwork (pilot plant testwork, i.e. 1 m disc balling and pot-grate firing).

2. The pot-grate test results showed that an acceptable pellet quality can be produced with the use of Peridur at an addition rate of 0.1%. However, it is likely that for acid pellet production, some flux addition (dolomite or limestone) may be necessary in order to meet all of the physical and metallurgical properties of fired pellets.

3. The pot-grate pellets with use of Alchem 8C26 as a binder even with some flux addition did not meet physical quality in order to warrant further testwork. With further optimization of ploymer 8C26 with respect to formula and its balling properties, it may be reconsidered as a potential organic binder. However, at this stage it appears that 8C26 should only be considered as a partial

substitute binder which is neither practical nor economical for the Carol Pellet Plant.

4. Based on the green ball and fired pellet properties produced with peat moss as a binder, it was found that an acceptable pellet quality can not be produced. Even though the testwork indicated that peat moss may be used on the basis of partial substitution (peat moss with bentonite) it is obvious that this would not be economically viable alternative.

   For details on Laboratory and pot-grate test results, see the C.R.M. report. For pellet quality specifications, see attached tables.

5. It is recommended that further pot-grate testwork be carried out with the use of Peridur as a potential binder, to establish the following:

   - optimum Peridur addition for acid pellet production (without any flux addition)
   - optimum Peridur addition for acid pellet mix and some flux addition
   - optimum dolomite and limestone addition rates
   - optimum firing cycles for various pelletizing mixes

The recommended testwork will conclude the Laboratory phase of the bentonite substitution program and will provide the necessary technical parameters for a potential commercial trial.

6. Since further testwork is required to establish an optimum Peridur addition rate and minimum flux addition rate (dolomite or limestone), in order to meet all of the properties of fired pellets, the economic aspect cannot be defined at this stage of the bentonite substitution program. However, based on the preliminary economic evaluation it appears that the unit cost for Peridur addition ($/t pellets) is about double of that for bentonite. Once the recommended testwork is completed, which will provide optimum Peridur and flux addition rates necessary to meet the pellet quality requirements, the detailed economic assessment will be possible. The economic evaluation will include the benefits and disadvantages of Peridur as a potential binder in place of bentonite. The detailed economic assessment will include the following:

- Improved weight yield (by about 0.8%) in the Concentrator due to 0.4% higher SiO2 concentrate.
- Possibility and benefits of producing lower SiO2 pellets 4.3% SiO2 compared to current 4.75% SiO2.
- Decrease in impurities in fired pellets contributed by bentonite.
- Improvement in reducibility of fired pellets and consequent blast furnace benefits.
- Higher price of Peridur compared to bentonite (higher unit cost per tonne of pellets with use of Peridur).
- Capital cost for Peridur handing and addition systems.
- Additional cost from flux addition (dolomite or limestone); purchase price, handling, grinding and addition systems.

The recommended pot-grate testwork and the detailed economic assessment will evaluate the overall viability of Peridur as a potential binder. These findings will redefine the technical and economical viability of the bentonite substitution program. It will also provide the data necessary to determine whether a Plant scale - commercial trial on one pelletizing line at the Carol Project is warranted as the next phase of the bentonite substitution program.

## ACID PELLETS - SPECIFICATIONS

| | |
|---|---|
| CHEMISTRY | SiO2 4.75% ± 0.2 |
| TUMBLE % - 0.8 mm | 4% ± 0.5 |
| Q-INDEX | 94.0 MINIMUM |
| COMPRESSION: | 230 KG AVERAGE MINIMUM |
| 2 SIGMA | 115 kg MAXIMUM |
| % - 90 kg | 5% MAXIMUM |
| LOW TEMPERATURE DISINTEGRATION (LTD): | |
| ( + 6.3 mm) | 90% MINIMUM |
| ( - 0.5 mm) | 5% MAXIMUM |
| SWELLING, % | 20% MAXIMUM |
| REDUCIBILITY - R40 | 0.8 MINIMUM |

# FLUXED PELLETS - SPECIFICATIONS

## CHEMICAL ANALYSIS (DRY)

| ANALYSIS | SPECIFICATION | ALLOWABLE RANGE |
|---|---|---|
| % Fe | 61.90 | --% |
| % SiO2 | 4.75 | ± 0.2 |
| % MgO | 1.80 | ± 0.2 |
| CaO/SiO2 | 0.90 | ± 0.10 |
| **COMPRESSION** | | |
| Compression | 205 kg | Average (Min) |
| 2 std. Deviation | 115 kg | Maximum |
| % -90 kg | 5 % | Maximum |
| **PHYSICALS** | | |
| % +6.3 mm A.T. | 95.0 | Minimum |
| % -0.8 mm | 5.0 | Maximum |
| Q Index | 94.0 | Minimum |
| **L.T.D.** | | |
| % +6.3 mm | 90.0 | Minimum |
| % -0.5 mm | 5.0 | Maximum |
| REDUCIBILITY - R40 | 1.20 | Minimum |
| SWELLING, % | 20.0 | Maximum |
| **PELLET SIZING** | | |
| % +12.5 mm | 10.0 | Maximum |
| % -12.5 mm + 9.5 mm | 80.0 | Minimum |
| % - 9.5 mm + 6.3 mm | 10.0 | Maximum |
| % - 6.3 mm | 1.0 | Maximum |